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The (mis)use of graphs

Insights into the Portuguese companies' annual reports

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Abstract

Graphs are a suitable format for summarizing and disclosing information in annual reports given that investors, and other addressees of graphs, may lack of the time required to fully analyse the information. Therefore, graphs should be reliable, accurate and free from material distortions. This Work Project aims to make aware of the importance that graphs have both for the report's users and the companies themselves. Moreover, this project investigates the potential roots of graphical distortions. The findings suggest that the correlation between the level of graph distortion in Portugal and the Board of Directors is moderate, although not significant.

Key Words: Company's annual reports; Graph Distortions; Board of Directors; Portugal

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1- INTRODUCTION

Companies communicate relevant information to stakeholders through the annual reports, and often display it in visual formats, such as graphs. Citing the definition of graph, by the Cambridge dictionary[1], a graph can be defined as "a picture that shows how two set of information or variables (amounts that can change) are related, usually by lines or curves". On the other hand, "graphs can also reveal patterns, cycles and underlying trends that may not be obvious from tables" (Courtis, 1997).

Given that users are very busy persons who lack of time and ability (Vázquez & Trombetta, 2007), required to obtain a full and correct picture of the company, they desire a summary form.

[1] Cambridge Dictionary. 2019. "Graph". https://dictionary.cambridge.org/pt/dicionario/ingles/graph (accessed December 15th, 2019).

Graphs serve that purpose, providing a summary which facilitates the understanding of a company's position or performance, as they allow users to save time, but are also visually appealing, facilitate the memory recall, highlight trends and different relationships between variables and breakdown language barriers (Courtis, 1997). However, it should not substitute a small narrative to explain data – that's what differ "friendly graphics" from "unfriendly graphs" (Tuft, 1986).

While financial information is important for investors and has being constantly displayed by companies, as exemplified by Ianniello (2009) and Chekkar and Martinez (2011), recent studies, such as Guddal (2016) and Núñez (2016) have shown that non-financial information is becoming visible due to corporate social responsibility issues.

The Management Board prepares the management report and decides about its contents and format of presentation. They can also exploit the good (or bad) performance of managers, as measured by the company's financial results. Annual reports are not just a financial document anymore, but also a way of communicating the corporate image and brand name (Beattie & Jones, 1999).

Auditors do not have any formal procedures in order to audit graphs[2]. Their main responsibility is to get significant evidence on whether the financial statements are correct or not regarding the level of materiality[3].

Despite the advantages that graphs might have, this Work Project provides evidence about the use and misuse of graphs in annual reporting, based on the most recent data available for Portugal

[2] Auditors do not have to audit "Other Information", which includes graphs (ISA, 2016)]. Instead, they only audit financial statements.

[3] "Information is material if omitting, misstating or obscuring it could reasonably be expected to influence decisions that the primary users of general-purpose financial statements make on the basis of those financial statements which provide financial information about a specific reporting entity." – **IFRS.** 2018. "IASB clarifies its definition of 'material'." https://www.ifrs.org/news-and-events/2018/10/iasb-clarifies-its-definition-of-material/ (accessed November 30th, 2019).

and respective largest companies. For instance, are these distortions pure accident or are they intentional?

This study contributes to the literature by alerting both regulators and the users of annual reports for distortions graphs may have and for the potential effects of such distortions. This study addresses for those who can be the possible roots of those graphical distortions. For instance, is there any association between the company's level of graphical distortion and the company's Board of Directors, who may want to portray a more favourable picture of the company's financial position or performance as a sign of the Board's good management?

This paper proceeds as follows. Section 2 introduces the main concepts required to understand the full paper, namely rules for a proper graph design and its possible distortions. Section 3 reviews the empirical literature about graph disclosures in annual reporting. Section 4 outlines the research questions and hypothesis to be tested considering a specific sample. Section 5 presents and discusses the main results. Section 6, lastly, summarizes the main conclusions taken from this Work Project and provides practical implications of the findings, recommendations to solve the problem and how future research may complement this paper.

2) NORMATIVE REVIEW

2.1) PRINCIPLES OF PROPER GRAPH CONSTRUCTION

There are many formats of graphs available for graph designers and their utility varies regarding the situation and the information one wants to display. While line charts are more suitable to represent trends, pie charts are preferable if a company wants to show the shares in relation to a whole (e.g. composition of sales per product). *(see Appendix 1 for more detailed information).*

Before stating what are the types of graphical distortions that arise, rules for proper graph design are reviewed. They should be applied by graph designers, who are responsible for the construction of graphs, and known by users, who must analyse them.

The main rules, developed during the last decade of the last century, are summarized in *table 1*.

Table 1: Rules for Proper Graphical Construction

Author	Rule(s)
Beattie & Jones (1997, 1998)	▪ The axis that form the framework should start from zero; ▪ When displaying time series, time should go from the left to the right; ▪ Graph designers should avoid three-dimensional graphs; ▪ Backgrounds shouldn't be obtrusive;
Courtis (1998)	▪ The size of the symbols (e.g. columns) should vary proportionally to the numerical values; ▪ Multiple scales or nonarithmetic scales shouldn't be used; ▪ Pie charts should have up to "five slices" and presented in a descending clockwise, from the largest to the thinnest sector.
Jarret & Babad (1981)	▪ A maximum of six colours should be used, with a proper legend.
Arunachalam (2002)	▪ Broken axis and the hiding of negative values should be avoided.

2.2) MISREPRESENTATION OF GRAPHS: TYPES OF DISTORTIONS

There are four types of distortions in graphs: Selectivity; Measurement Distortion; Orientation Distortion and Presentational Enhancement. These distortions, displayed on graphs, aim to portray a favourable picture of the company's "financial health" or Corporate Social Responsibility.

Selectivity occurs when the choice of the variables to be displayed on graphs depends on the company's performance regarding those or other variables (Beattie & Jones, 2008). That is, in order to give a favourable picture of the company, if it is performing well, companies choose to display them; if the company is poorly performing, the opposite usually happens.

Measurement distortion occurs when the physical size of the graph does not vary proportionally to the underlying numbers (Beattie & Jones, 2008) (*see Appendix 2 as an example).* Those distortions may be favourable to the company in the sense that companies that are performing well exaggerate those positive results and the ones who have negative results tend to understate the negative/unfavourable trend. The opposite may also happen, that is, an exaggeration of negative results or understatement of positive results, representing unfavourable Measurement Distortions.

Measurement Distortion arises from a misrepresentation of graphs, portraying an unreal financial position or performance by the company (Beattie & Jones, 1999). While the other types

of distortions are technically accurate, this distortion is not accurate and deceive people. Three measures have been developed by different authors, as outlined on the following table:

Table 2: Formulas for Measurement Distortion

Author and Year	Formula	Materiality	Legend
Tuft (1983)	$LF = \frac{Size\ of\ the\ effect\ show\ in\ the\ graph}{Size\ of\ the\ effect\ in\ data}$	LF is greater than 1.05 or less than 0.95.	LF=Lie Factor
Taylor and Anderson (1986)	$GDI = 100\% * \left(\frac{a}{b} - 1\right)$	GDI is greater than 1.05 or less than 0.95.	GDI=Graph discrepancy Index *a*= percentage change depicted in the graph (physical change, represented for example by the change of the column height between two periods); and *b*= percentage change in the data
Mather, Mather & Ramsay (2005)	$RGD = \frac{g2 - g3}{g3}$	RGD is greater than 1.025 or less than 0.975.	RGD= Relative Graph Discrepancy *g2* is the height of the last column $g3 = \frac{g1}{d1} * d2$, where *g1* is the height of the first column *d1* is the value of the first column *d2* is the value of the last column

Presentational Enhancement occurs when there is a violation of any principles regarding the formatting and construction of the graph that may lead to some distraction or lack of accuracy when analysing the graph. It may happen through the colour, scale, emphasis of some graphs (Penrose, 2008) and other treatments such as visual effects from three dimensional graphs and shading of data markers (Courtis, 1997).

A problem arises when it makes it difficult to decipher data and alter the real message of it, which affects the communication effectiveness (Courtis, 1997).

Orientation Distortion, on the other hand, appears when the slope parameter of the graphs diverges from 45 degrees[4]. Although the graph is "technically accurate", it "does not facilitate the accuracy of judgements upon it" (Beattie & Jones, 1997) (e.g. a great slope may be used to enhance

[4] Orientation Distortions can only be measured on graphs that have rectangles (bar, columns, stacked column or stacked bar). For that, one needs to measure the angle between the rectangle of given variable on time N-1 and the rectangle of the same variable on time N using a protractor. There is Orientation Distortion if the angle diverges from 45º.

the positive growth of the results. Regarding, the optimal angle, it should be around 45º [Cleveland & McGill (1987)].

2.3.) IMPRESSION MANAGEMENT

Impression Management is the Management's manipulation of company's data in a favourable way. It is associated to the Management Board's attempt to convince the shareholders that they are running the company very efficiently (Goundar, 2009).

The various types of distortions may be associated to Impression Management. Companies may select the graphs that are favourable for them through Selectivity; they can overstate the positive results and/or understate the negative results by Measurement Distortion or Orientation Distortion; or mislead the user by adopting other design techniques, with Presentational Enhancement through the use of certain colours, multiple scales, among others. The several types of distortions are different aspects of Impression Management, portraying a favourable picture of the financial position of the company or of its performance. The users of annual reports should be aware of them.

3) PRIOR EMPIRICAL RESEARCH

Empirical studies about graphs disclosures in annual reports cover the period from 1965 to 2014 and with samples from the five continents[5] *(see Appendix 3.1).* Those studies characterize the usage of graphs, describing aspects such as location, span of time type, and colours of graphs. An important topic researched is the identification of key financial variables (KFVs), which is found to be more frequently graphed than non-financial ones. Moreover, distortions were found in graphs

[5] In Africa, only South Africa was studied; in Oceania, both Australia and New Zealand were covered , in America, Brazil, Canada, Mexico and U.S. make part of the analysis; in Asia, both Hong Kong, Israel, Malaysia, Philippines and Turkey were covered; finally, in Europe (the most analysed continent), Denmark, France, Germany, Ireland, Italy, Netherlands, Norway, Portugal, Spain and U.K. were also studied.

presented in the annual reports, namely Selectivity, Measurement Distortion, Presentational Enhancement and Orientation Distortion, although not every study covered all these points.

3.1) USAGE OF GRAPHS AND KEY FINANCIAL VARIABLES GRAPHED (KFV)

Regarding the usage of graphs, South Africa, analysed for the period of 1984-1994, and Asian companies [Frownfelter-Lohrke & Fulkerson (2001) for Hong-Kong and Israel in 1984-1994] disclosed a relatively low quantity of graphs for the periods of analysis. The percentage of companies disclosing graphs varies from 35.47% found for Hong-Kong (Courtis, 1997) to 75% found by Uyar (2011), for Turkey.

The average number of graphs disclosed per annual report ranged from one-point five percent in Malaysia, in the year 1984 [Rahman, Hamdan & Ibrahim (2014)] to ten, later in 1984-1994, found for Hong-Kong (Frownfelter-Lohrke & Fulkerson, 2001).

Elsewhere, graph usage is much greater. Regarding the percentage of companies displaying graphs, it ranges from 50% in 2009, evidenced by Nascimento, Rodrigues, Albuquerque and Silva (2013) in Brazil to 94% in 2013 for Portugal, concluded by Bastardo (2015).

Regarding the format of graph adopted to display information, column graph is the dominant format. For instance, Nascimento et al. (2013) and Núñez (2016), both for Brazil; Courtis (1997) for Hong-Kong; Ianniello (2009) for Italy, among others, concluded that column graph was the most adopted one in their researches.

In what regards the contents of the graphs, overall, the most disclosed variables are KFVs, such as Sales, Earnings per share (EPS) and Dividends per share (DPS)[6]. Four studies show all these variables to be KFVs in company's annual reports, in samples from Australia (Beattie & Jones, 1999), France (Beattie & Jones, 2000a), U.K. (Beattie & Jones, 1997) and the U.S. (Beattie &

[6] The later two variables are of utmost importance for shareholders.

Jones, 1997)]. Many other studies found evidence of disclosure in graphs of at least one of the KFVs above mentioned, as for example Courtis (1997); Beattie and Jones (1999, 2000a); Benau, Miralles and Martínez (2009). It is worth noticing that studies based in samples from Latin countries, apart from Spain (Benau et al. 2009), do not present graphs for any of the said KFVs, for example in Brazil (Nascimento et al. 2013; Miranda, Vieira, Lagioia & Vasconcelos, 2008; Núñez, 2016); Italy (Ianniello, 2009) and Portugal (Wozniak, 2011; Bastardo, 2015).

3.2) DISTORTIONS IN GRAPHS

The findings about Selectivity Distortion are not consensual. On one side, evidence of Selectivity Distortion was found in several annual reports, such as in Australian companies for the years 1991 and 1992 (Beattie & Jones, 1999; 2000a), in the U.S., for 1990-1991 and 1992 (Beattie & Jones, 1997; 2000a); for 1986 (Steinbart, 1989) and more recently in 2005 (Dilla & Janvrin, 2010). In Europe, evidence of Selectivity Distortion was found in Spain (Benau et al. 2009) for the reports of 2003; in the U.K. for the 1965-2004 period (Beattie, Dhanani & Jones, 2008) and again for 1989, 1990-1991 and 1992, respectively (Beattie & Jones, 1992; 1997; 2000a). On contrary, Guddal (2016) did not conclude about the existence of Selectivity Distortion in the 2014 annual reports of Norwegian companies. In Portugal, contradictory results were found for two different periods: Wozniak (2011) concluded that there is evidence of Selectivity for 2009 whereas Bastardo (2015), four years later, concluded the opposite based on the annual reports of 2013, thus being possible that in Portugal, the situation regarding this type of distortion had improved. This contradictory result justifies the insistence in studying this country.

Concerning performance of a variable as a cause of Selectivity, the inclusion of a given financial graph displayed by the company was highly associated to the financial performance, represented by certain financial variables. Examples are EPS as evidenced by Beattie and Jones (1992,

1997,2000b); Beattie et al. (2000) and Dilla and Janvrin (2010); Earnings, evidenced by Beattie and Jones (2000b) and even Earnings Before Taxes (EBT) and Net Income reported by Dilla and Janvrin (2010). On the other hand, the inclusion of a given graph for a particular variable also depended on the performance of those variables. That is the case of Sales and EPS, both concluded by Benau et al. (2009); Net Income, as found by Benau et al. (2009) and Wozniak (2011) and Earnings Before Interest Taxes Depreciation and Amortization (EBITDA) evidenced by Wozniak (2001).

Despite rare inconsistencies in some variables such as Net Income (Bastardo, 2015)], companies are more likely to display more graphs if the situation is favourable rather than unfavourable. In those cases, companies may want to present graphs in order to justify the decrease of the results (Miranda et al. 2008). Again, Impression Management stresses here.

Regarding Measurement Distortion, the studies provide evidence of misleading graph constructions.

The percentage of companies that show evidence of Measurement Distortion, Courtis (1997) found that 72% of the companies in Hong Kong had at least one misleading graph for 1992-1993 and 1994-1995. In a study of companies in Italy, Ianniello (2009), concluded that 17.3% of them had at least one graph with a material KFV distortion for 2005.

The percentage of graphs with material distortions varies very much across countries. It ranges from 19.4% evidenced in Norway (Guddal, 2016) for 2014 to 73% found in Portugal (Wozniak, 2011) for 2009. In between, only studies regarding U.K. for 1980 (Beattie & Jones, 1992) and 1990-1991 (Beattie & Jones, 1997) provide evidence of material Measurement Distortions in less than 35% of graphs, while for U.K. in 1980 (Beattie & Jones, 1992); Spain in 2003 (Benau et al. 2009); Hong Kong in 1992-1993 (Courtis, 1997) and Brazil in 2014 (Núñez, 2016) , more than 35% of graphs have evidence of material Measurement Distortions.

The level of Measurement Distortion is diverse when comparing different countries and periods of time. Comparing the average Measurement Distortion between countries, while in the U.K. for 1990-1991, it was six-point nine percent (Beattie & Jones, 1997), in the U.S., on the other hand, presented a much greater level of distortion level in the decade of 1984-1994 for financial graphs (81%), as evidenced by Frownfelter-Lohrke & Fulkerson (2001).

Like in Selectivity, with the only exception of Norway for 2014 (Guddal, 2016), also Measurement Distortions suggest the pretension to give a favourable portray of the company rather than an unfavourable one. Again, Impression Management stresses here.

There are several studies regarding Presentational Enhancement, although it is the least studied type of distortion of graphs. The conclusions are regarding the average of unconformities per graph and the most common violated graphing rules. Comparing results between different studies, it ranges from 1.4 found for Norway in 2014 (Guddal, 2016) to 1.9 found for Portugal in 2013 (Bastardo, 2015). The most common violated graphing rules varies between the lack of proper guidelines; three dimensional graphs; no zero-base line; a different colour to the highlight the last year and the presence of multiple scales. Regarding the level of Orientation Distortion, on the other hand, only Beattie and Jones (1997) studied the deviation from the optimal angle for U.S. and U.K. for 1990-1991. The mean deviation was 16.4%.

As a conclusion remark, there is no consensus in the literature regarding the existence of graph distortions. Different countries and their respective companies, under diverse environments, may try to portray distorted realities in graphs. On the other hand, evolution and learning happens over time, and that may explain differences found in distortions in the same country over time. In Portugal for instance, different conclusions were taken by Wozniak (2011) and Bastardo (2015) regarding the existence of graph distortions. Both studies reported a great usage and misuse of

graphs. However, Wozniak (2011) concluded, for 2009, that there was no Selectivity, while Bastardo proved the opposite, four years later. Regarding the Measurement Distortion, although the percentage of material distortions has decreased from 73% (Wozniak, 2011) to 56% (Bastardo, 2015), the level of favourable cases have increased very much, from 56% to 73%, which evidences greater levels of Selectivity and favorable Measurement Distortions observed in this country. Therefore, it is relevant to study the country again.

Preparers and users of annual reporting should be aware of the characteristics of graphs disclosure in the annual reporting, the distortions they may have and how and why they mislead, pointing out what are the possible roots behind such distortions.

4) RESEARCH DESIGN

4.1) RESEARCH QUESTIONS, HYPOTHESES AND METHODOLOGY

This Work Project investigates the graph disclosures in the annual reports of Portuguese listed companies, with the purpose to describe the characteristics of graphs disclosure and to find out which distortions are present on graphs, whether they are significant or not, and why do they occur. The research is both descriptive and explanatory and has two parts. First, it obtains evidence about the formats of graphs that are used, and content displayed. Moreover, the distortions are quantified per company, in order to find the main roots of such graph distortions (based on the company's characteristics) for the second part of the statistical section of this research.

Three exploratory research questions in this Work Project help to portraying use and misuse of graphs in the annual reports of the Portuguese listed companies, stating whether companies used graphs, the characteristics of such disclosures, namely the format of graphs disclosed (RQ1), the disclosed content (RQ2) and the evidence of graph distortions (RQ3). They are as follows:

Table 3: Research Questions

RQ1	*Which formats of graphs are used?*
RQ2	*What content is displayed graphically?*
RQ3	*Are graphs constructed properly, based on the guidelines above mentioned in the study?* **RQ3.1.** *Is there evidence of Selectivity Distortion?* **RQ3.2.** *Is there evidence of Measurement Distortion?* **RQ3.3.** *Is there evidence of Orientation Distortion and Presentational Enhancement?*

Additionally, some hypotheses were outlined, to know whether companies misuse graphs. If they were distorted, the study aims to explain those distortions.

As an auxiliary to define the roots of graphical distortions, four hypotheses were developed, as follows.

Table 4: Hypotheses

H1	*The more resources (i.e. assets) the company has, the lower the number of distortions per graph.*
H2	*PSI-20 companies provide more distortions per graph.*
H3	*The greater the Time-Length graphed the greater the level of graph distortions.*
H4	*The lower the time until a Board of Directors is about to change, the lower the number of graph distortions.*

Univariate analysis is used to answer to RQ1 and RQ2, whereas for RQ3, a bivariate analysis was conducted. In order to conclude about the existence of graph distortions on RQ3, it was conducted a Z-Score test[7], considering a 95% confidence interval[8].

To answer to the hypotheses stated above, a matrix was designed in order to find out which variables that are behind those hypotheses are correlated to the number of significant Measurement Distortions per graph. The following explanatory variables that were considered regard the

[7] A Z-score is a way to compare results in a normal distribution. In this case, it is not possible to prove that the level of distortion is normally distributed, but since the N (number of graphs analysed) is greater than 30, the Central Limit Theorem can be applied, which means that the sample mean is normally distributed and therefore, the necessary statistical tests can be performed. Since zero is the centre of a normal distribution, the greater the z-score, the greater will be the probability of rejecting a null hypothesis that one defines.

[8] A confidence interval is the probability that one does not reject a null hypothesis when it is actually true. The greater the confidence interval, the greater will be the level of assurance – strength of the statistical results. 95% is the most common confidence interval used on statistical studies.

company size, namely Total assets (in million euros); whether the company is a PSI-20 [9](dummy variable); the average Time-Length displayed per graph and per company, on average; and number of years to terminate the mandate of the current Board of Directors. The variable to be correlated to, is the number of favorable Measurement Distortions per graph. [10]Regarding the type of distortions used, only the Measurement Distortion is tested[11]. For each coefficient of correlation between those variables, a *p-value* was computed, to measure the strength of those correlations.

4.2) SAMPLE AND DATA COLLECTION

The initial sample is compounded by all the 56 companies listed on the Euronext Lisbon on June 30, 2019. In order to analyze the graphs disclosed by these companies, the most recent annual reports provided by this "population" were gathered from two sources of data: the Stock Market Authority (Comissão de Mercado dos Valores Mobiliários, CMVM) and the company's website, depending on their availability. Due to annual report unavailability, not reporting in euro currency, not disclosing the external audit report and not being headquartered in Portugal, six companies were eliminated [12]. Additionally, ten other companies were excluded from the sample because they did not display graphs in their annual reports. Therefore, 40 companies compound the final sample.

[9] PSI-20 or Portuguese Stock Index is composed by the companies with largest market capitalisation [(Capital.com "Psi 20 Index". https://capital.com/psi-20-index-definition. (Accessed on December 22, 2019)]. Although it was composed by 20 companies in the past, today, PSI-20 is composed by only 18 companies [Euronext. "PSI 20". https://live.euronext.com/pt/product/indices/PTING0200002-XLIS/market-information. (Accessed on December 22, 2019)].

[10] The Measurement Distortion was computed with a ruler, comparing the growth of the size of the column with the growth of the real value (growth rate). It is only considered the material distortions, as suggested in prior studies, since they're more likely to influence investment decisions.

[11] It is the most critical type of distortion, that results from a mistake when constructing the graph. That's the distortion that is technically inaccurate, hence the choice.

[12] MULTI 24 did not have the annual report available and FLEXDEAL did not provide consolidated accounts; ISA provided results in Colombian pesos, rather than in euro currency; RAIZE is a very recent company to be considered for this analysis; OREY did not provided an audited report and EDP RENOVÁVEIS is headquartered in Madrid (Spain).

These companies belong to several sectors, namely Industrial Goods & Services; Banks; Utilities, among others; they have different sizes[13], which ranges from circa €15 million by LISGRAFICA to €76.000 million by BANCO COMERCIAL PORTUGUÊS and the larger of them some are part of PSI-20[14].

4.3) DATA ANALYSIS

The total number of graphs analyzed is 786, with an average of 19.65 graphs and a median of 13 (i.e. 50% of the companies displayed up to 13 graphs). Two companies (NEXPONOR and SONAE COM) display the minimum number of graphs (only one graph), and the maximum is 85 (NOS). The standard deviation, on the other hand, is 18, which shows a great dispersion regarding the usage of graphs. In fact, among industries, there are clear differences regarding the usage of graphs. If in the one hand "Basic Materials", provided seven graphs in the annual report, the "Utilities" sector, on the other hand, represented by EDP and REN, display 37 and 49 graphs, respectively.

Comparing PSI-20 with non-PSI-20 companies, there is a great discrepancy regarding the usage of graphs. While PSI-20 companies display an average of 32.75 graphs per company, the average of graphs displayed by non-PSI-20 companies is much lower (10.92). This may be explained by the fact that PSI-20 companies are larger than the remaining ones, as size (proxied by Total Assets) is highly correlated with the number of graphs (coefficient of correlation of 0.49 (*p-value=0.0013*, approximately). Net income and Revenues, on the other hand, are also highly correlated to the usage of graphs (coefficients of correlation of 0.39 (*p-value=0.01*) and 0.48 (*p-value=0.0017*), respectively).

[13] Size is measured by total assets (in million).

Comparing past studies done for the Portuguese case and regarding the usage of graphs, the average of graphs per company has been decreasing. In companies common to this study and the one previously done by Wozniak (2011), the average decrease from 23.59 graphs per company to 20.49 graphs per company. Moreover, the standard variation decreased from 26.30 to 18.96 graphs per company, which means that the dispersion regarding the number of graphs per company displayed on annual reports decreased.

Regarding the location of graphs, the results show that most of graphs are in the Management Report. In fact, 72.23% of graphs analyzed are in the Management Report. Furthermore, considering the percentage of companies displaying graphs in the Management Report, only 15% of the graphs analyzed do not display any graph in this section of the company's annual report.

Although the report considers the current financial year, it is noticeable that companies display in graphs several years to show the evolution regarding a given variable (E.g.: Sales). In in the one hand many graphs consider only one year, on the other hand, 66% of the total graphs analyzed display data for more than one year (*see Appendix 4*).

5) RESULTS

5.1. FORMAT (RQ1)

As mentioned in Section 2, different formats of graphs have different uses. In this research, RQ1 can assume the following formats: column; doughnut; stacked (column; bar); line; mixed (column + line; stacked column + line); bar; pie; area and others (*see Appendix 5*).

The most used format of graph is the column one, with circa 35.11% of all the graphs disclosed, as shown in *Appendix 6.* This difference becomes even more evident regarding the percentage of companies using these two formats of graphs, as 87.50%[15] uses at least one column graph.

[15] Only COFINA, FLEXDEAL, GLINTT, INAPA, OREY and SONAE COM do not display a column graph.

Comparing these findings with prior studies conducted for Portugal, it became evident that the prevalence of column graphs persists since, like in this study, column graph was also found to the most frequent format for Portugal in 2013 (Bastardo, 2015) and in 2009 (Wozniak, 2011). On the other hand, the doughnut chart is becoming more popular [16.54% of graphs versus 6% evidenced by Bastardo (2015)], which shows that companies are diversifying towards more sophisticated formats of graphs when displaying information. Besides the sophisticated formats, companies are also adopting sophisticated backgrounds throughout the usage of colors. For instance, in this study, the average of colors per graph is 1.77 (*see Appendix 7.1* for detailed information).

5.2) CONTENT (RQ2)

The content of graphs was grouped into 12 categories: HR & Safety; Revenues; Operations/Strategy; EBITDA; Capital Market Data; Sustainability & CSR; Industry/Macroenvironment; Debt; Net Income; Corporative; Residual Financial Information and Others (see *Appendix 8)*. The information classified as "Residual financial information[16]", represent 18.19% of the graphs analyzed. However, individually, HR & Safety and Revenues are the most displayed variables, accounting for 14.12% and 11.07%, respectively, of the total graphs analyzed. Regrouping information content of graphs into the two categories (Financial and Non-Financial),[17] the financial information is the most displayed content. In fact, 90% of the companies include at least one graphic displaying financial information. Due to the importance of such information, shareholders of companies hire auditors to be their "eyes" in the company and that is why companies, in this sample[18], paid an average of 484,544.00 euros to be audited, in 2018.

[16] It includes all the remaining financial variables that were not enumerated individually.
[17] The non-financial category includes six of the 12 types of content displayed on *Appendix 8:* HR & Safety; Operations/Strategy; Sustainability & CSR; Industry/Macroenvironment; Corporative and Others.
[18] FARMINVESTE, FUTEBOL CLUBE DO PORTO, NEXPONOR, PATRIS and SPORTING DE BRAGA, did not display the amounts paid on auditing. Therefore, this average considers 35 companies rather than 40.

Additionally, companies disclose non-financial information in graph formats, namely about Human Resources (HR) & Safety and Sustainability & Corporate Social Responsibility (CSR), representing 14.12% and 9.50%, respectively, of total graphs. These are "fashionable" topics, and indeed more and more important topics and it is not by chance that 25 (62.5%) companies provide at least one graph displaying one of these two variables. While in 2013, Human Resources and Sustainability represented 13% of the graphs (Bastardo, 2015), in this study, this percentage increased to 22.77% in 2018.

Looking more in depth into the financial information, which is the core topic of most[19] annual reports[20], five financial topics are highly displayed on graphs: Revenues; EBITDA; Debt; Capital Market Data and Net Income, which are variables of performance and financial position. More than 48%[21] of companies present at least one graph for each of the mentioned topics. On the other hand, only 7.3%[22] of companies do not display any of these five topics. More detailed information is shown in *Appendixes 8 and 9.*

5.3) DISTORTIONS (RQ3)

RQ3.1) SELECTIVITY

The analysis of Selectivity was done regarding variables that represent performance, rather than graphs[23]. The total number of variables (can be repeated in the same graph)[24] analyzed was 226,

[19] Note that, 26.09% of the companies provide more financial than non-financial information. That's the case of ALTRI; CONDURIL; CTT; FARMINVESTE; MARTIFER; MEDIA CAPITAL; NEXPONOR; PATRIS; REN; SAG; SONAE INDÚSTRIA and VISTA ALEGRE.

[20] In this section of the Work Project, variables related to the defined KFVs were also considered and studied regarding Selectivity and Measurement Distortions. E.g.: Debt/EBITDA.

[21] For RQ3, only the companies that present financial information, are analysed. That is the case of 36 companies - CONDURIL, INAPA, NEXPONOR and VISTA ALEGRE were, for these reasons, excluded.

[22] Three companies (out of 40) do not provide any of these KFVs. They are MEDIA CAPITAL; THE NAVIGATOR and TOYOTA CAETANO.

[23] Note that one graph can be displaying two categories of data (when a graph has two multiple scales, for example).

[24] For example, Revenues per Segment. If a graph displays the Revenues for four segments, we have a graph with four sorts of data representing Revenues.

displayed in 153 graphs, which gives an average of 1.48 variables per graph (excluding the graphs with only one variable, this average increases to 3.21 variables per graph).

In order to compute Selectivity, two steps were taken for every variable about the KFV displayed on graphs (Debt; Revenues; Net Income; EBITDA and Market Capital Data).

(i) To select the variables that represent performance and to measure their variation, which defines its own performance (favorable if there is a positive variation or unfavorable in case of a negative variation).[25]

(ii) To classify the distortion into favorable or unfavorable.

The results are as follows:

Table 5: Selectivity Distortion

Variables	Favorable Change (Selectivity)	Unfavorable Change	Total	% Favorable Change (Selectivity)	Z-score
Debt	32	8	40	80.00%	4.68
Revenues	69	40	109	63.30%	2.87
Net Income	10	8	18	55.56%	0.46
EBITDA	29	42	71	40.85%	-1.55
Market Capital Data	4	6	10	40.00%	-0.61
Total	144	104	248	58.06%	2.57

Looking at the results, more specifically at the Z-score, it is concluded that there is statistical evidence of Selectivity Distortion (considering a confidence interval of 95%) since Z>1.96 (Z=2.57) and therefore, the hypothesis that the percentage of variables which display favorable changes is not greater than the ones which display unfavorable change, is rejected. In other words, the result suggests that companies have the intention to select (exclusively) the variables which portrays a more positive picture of the current financial situation. This may be explained by the method used on Management performance's evaluation. For instance, it is largely dependent on

[25] This is only the case for Profit variables.

the firm's performance and therefore managers may attempt to manipulate the data, portraying a more favorable picture of the company (Impression Management) (Goundar, 2009).

Looking at each variable individually, EBITDA, Net Income and Market Capital Data, there is no evidence of Selectivity Distortion regarding these variables. These results confirmed previous results obtained by Beattie and Jones (1999) for Australia in 1991,and Benau et al. (2009) for Spain in 2003, and moreover by Wozniak (2011), for Portugal in 2009, but contradicted more recent results obtained by Bastardo (2015), for Portugal in 2013 and Guddal (2016), for Norway in 2014.

It is evidenced that Selectivity Distortion exists in the graphs displayed by Portuguese listed companies in the 2018 annual reports. It is, therefore, quite important that the users of the annual reports are aware of that and pay attention to relevant variables that are not displayed on graphs, given that normally, companies only display the variables that are favorable to the company, stressing, once again, the importance that Impression Management has for company's managers.

RQ3.2) MEASUREMENT DISTORTION

In order to analyze Measurement Distortion, this study uses RGD[26] instead and the calculation is done for the same variables referred previously, when detecting Selectivity. Prior studies, as Beattie et al. (2008) for U.K. and Steinbart (1989) for U.K., used GDI instead of RGD. However, the later has advantages over the former (GDI)[27].

For the Measurement Distortion, two analysis were done. First, finding out the percentage of variables that are significantly distorted and then split it into favourable (overstating favourable trends and understating negative ones) and unfavourable distortions (understatement of a

[26] The reference value was two-point five percent, to separated material distortions from non-material ones [(Mather, Mather & Ramsay, (2005)]

[27] The upside of RGD is that it is not so sensitive to small changes in data; it automatically distinguishes different nature of distortion, without having to analyse the trend of data to check if the distortion is favourable or not, contrarily to GDI (Mather, Mather & Ramsay, 2005).

favourable trend and overstating a negative one). The first part of the analysis is summarized on *Table 6* and the second one on *Appendix 10*.

Table 6: Percentage of Material Measurement Distortions

Variables/Significant Distortions	#	Variables Displayed	% Material Distortions	Z-Score
Revenues	38	113	33.63%	-3.32
EBITDA	39	75	52.00%	0.71
Debt	22	40	55.00%	0.99
Net Income	12	18	66.67%	1.86
Shares	4	10	40.00%	-0.65
Total	115	256	44.92%	1.17

Great part of graphs is materially distorted, mainly Net Income. On the other hand, the hypothesis that the percentage of distorted variables is equal or below to that of non-distorted ones cannot be rejected (Z-score<1.96), meaning that there is no significant evidence of Measurement Distortion. This result may be explained by the companies' intention of granting a better public perception of companies' traded securities, achieved through more accurate and reliable information (Barako, Hancock & Izan, 2006).

Considering this part of the analysis and having the material distorted variables identified, it is relevant to find out if these distortions are either favorable or unfavorable to the company.

Looking at *Table 6*, it is possible to conclude from the variables which are materially distorted, most of distortions are favorable to the company. However, to conclude whether this is pure accident or intentional, the following statistical test (Z-Score) must be performed:

$$H_O: U_F \leq 0.5 \; versus \; H_1: U_F > 0.5, U_F = \%\, of\ favourable\ cases \quad [1]$$

Table 7: Number of Favorable versus Unfavorable Distortions

Variables/Significant Distortions	Overstating favorable trends	Understating unfavorable trends	No. of favorable distortions	Understating favorable trends	Overstating unfavorable trends	No. of unfavorable distortions
EBITDA	12	16	28	5	6	11
Revenues	12	8	20	9	7	16
Debt	13	2	15	6	1	7
Net Income	3	2	5	5	2	7
Market Capital Data	2	1	3	0	1	1
Total	42	29	71	25	17	42

Performing this test, the Z-Score obtained was 2.31[28]. If these Measurement Distortions were unintentional, there should be as many unfavorable distortions as favorable ones or more unfavorable distortions than favorable ones. However, the opposite happens, and that difference is significant. Therefore, although there is not statistical evidence of Measurement Distortion, when it happens it is, most of the times, favorable to the company. This result goes against the "innocence" or lack of knowledge from companies that could explain the absence of Measurement Distortion concluded previously, since, in this point, companies seem to know very well how to portray a favorable picture of their financial reality.

On the other hand, more and more variables have been portraying a favorable picture of the companies' financial reality. For instance, if in 2009, the percentage of favorable distortions was 59% (Wozniak, 2011) and in 2013 it decreased to 53%, in this study, this percentage was 62.61 percent in the last financial year (2018).

The users of annual reports should, therefore, pay more attention to numbers rather than the graphs. At least, both should be taken into consideration.

RQ3.3) PRESENTATIONAL ENHANCEMENT AND ORIENTATION DISTORTIONS

There is a great evidence of the existence of *Presentational Enhancement*. In this analysis, it was detected 354 violations of this type of distortions in 277 graphs, which translates into an average of 1.19 violations per graph (*see Appendix 11.1*). Comparing the result obtained with previous studies, such as Bastardo (2015), Guddal (2016) and Núñez (2016), for Portugal, Norway and Brazil in 2013, 2014 and 2014, respectively, this value is the lowest one. The most common violation was the lack of a Zero-Base line, responsible for 49% of all the Presentational Enhancement Distortions.

[28] That means that we reject the Null hypothesis since 2.76>1.96 (based on α=0.05).

Orientation Distortion is also evidence in this research. For instance, only 9.52% of the graphs analyzed have a difference up to 10º from the optimal angle (45º). On the other hand, 71.90% of the graphs analyzed display an angle, whose difference is at least 20º greater than the optimal angle (*see Appendix 12.1*).

5.4) CORRELATION ANALYSIS (H1 – H4)

Looking at the correlation matrix in *Appendix 13.1*, it is evidenced that there are two important variables that may explain the existence of graph distortions, namely the Board of Directors and the Time-Length (number of periods) displayed on graphs.

The correlation between the Board of Directors (BoD) and the number of Measurement Distortions per graph is positive and moderate (0.409). The signal means that the higher the number of years until a change on the Board of Directors[29] occurs, the higher the number of Measurement Distortions per graph. This fact is supported by the Impression Management theory. The logic behind it is that directors must perform well (based on financial results) in order to keep the position; if they are close to the end of the mandate, they do not need to work hard/show good results (they will leave the company anyway). However, looking at *the p-value* of the correlation between the variable BoD and the number of significant Measurement Distortions per graph, the *p-value* (regarding the beta of BoD) is not low enough (16.52%) to reject the following hypothesis: $r=0$.[30]

On the other hand, there is also a substantial positive correlation (0.517) between the number of Measurement Distortions per graph and the average Time-Length displayed on graphs. It means

[29] The group and the company's financial statements are prepared by directors, who have the responsibility to check whether the annual report includes a fair review of the company's financial position. **HomeServe.** "Director's Responsibilities". https://www.homeserveplc.com/investors/annual-report-2019/governance/directors-responsibilities.aspx (accessed November 11, 2019).

[30] The hypothesis being tested is r (coefficient of correlation) between the BoD and the number of significant Measurement Distortion per graph.

that graphs that display a greater number of years on graphs, tend to be more distorted. The rationale behind this result is that graphs which display data about a greater number of periods are the ones who were performing worse and now are performing better or the ones who were performing well and now are performing even better. Not only companies want to show that, but also distort data in order to enhance the evolution. This is also evidence of Presentational Enhancement!

Therefore, the stakeholders to whom the annual report address should pay attention if a graph display a great Time-Length and if the Board of Directors just has started the mandate. In such context, graphs are more likely to distort!

6- CONCLUSION

This Work Projects analyzed the use and misuse of graphs, based on a sample of the 2018 annual reports from 40 Portuguese companies with shares listed on Euronext Lisbon, with the aim at exploring the characteristics of the graphs and the existence of graphical distortions. Overall, 786 graphs were analyzed!

This study adds to the literature of voluntary disclosure in annual reports, with data for a country whose Selectivity Distortion and percentage of favorable Measurement Distortion have risen. Moreover, the last study was conducted five years ago.

The results suggest that graphs are very common forms of communicating information in the annual reports by Portuguese listed companies, although the average of graphs per company has slightly decreased, comparing to 10 years ago. Companies mostly disclose column graphs and provide mainly financial but also non-financial information (e.g. Human resources thematic and environment) which shows that the company is acting in a socially responsible matter.

The existence of a misuse of graphs is excessive in Portugal. In fact, this study found evidence of Selectivity Distortion, which means that companies are displaying graphs depending on the

performance of the variables, yet there is not statistical evidence of Measurement Distortion. However, in the cases in which Relative Graph Discrepancy (RGD) is significant, the graphs disclose more favorable than unfavorable information to the company and the difference is significant, affecting further investment decisions.

Trying to explain those distortions, only Time-Length and Board of Directors were found to be correlated to them. That's Impression Management. While Board of Directors are more likely to show good results in the beginning of the mandate, greater Time-Lengths are frequently in order to show a greater financial performance, mainly when past results were shameful.

For future research, given the greater importance that non-financial variables have had, it is important to compute the RGD or GDI for those graphs. For instance, do companies want to look more socially responsible than what they are in the reality? Furthermore, more studies and more data could be collected regarding the Board of Directors in order to explain and find the causes for graphical distortions. For this case, a small database for the number of years until a change on the Board of Directors occurs is a limitation of this study.

The research addresses to regulators. It is recommended that proper guidelines are developed in order to prepare and audit the graphs. On the other hand, in view of reducing the level of distortions, one prize could be provided to the company with the best annual report regarding the level of distortions (the company with the least number of favorable distortions per graph could be prized). Alternatively, negative incentives for companies with higher level of distortions in annual reports should be acknowledged.

This way, we would have a graph use rather than a graph (mis)use…

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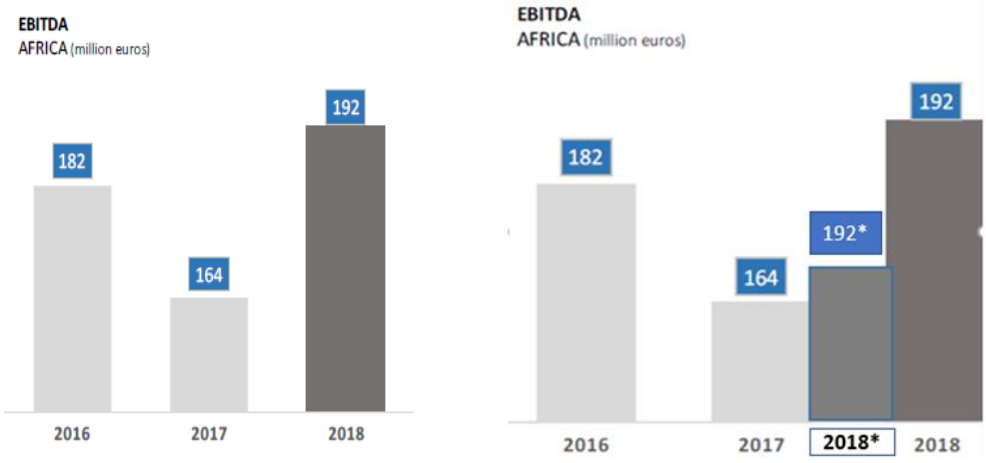
Appendix 1: Other graphical Rules

Author	Year	Rule(s)
Beattie & Jones	(1997; 1998)	▪ The axis that form the framework should be perpendicular (form a 90º slope). ▪ The gridlines should be thin; ▪ When displaying time series, time should be displayed in the horizontal axis. ▪ The width of specifiers and spaces between them should be uniform; ▪ The choice of colours should be done carefully. ▪ Graph titles, descriptive and numeric axis labels should be meaningful and properly indicated; ▪ Numeric labels should be close to the axis and horizontally; ▪ The slope parameter of the axes' scales should be close to 45º.
Courtis	1998	▪ Time series should be properly labelled due to the cultural differences across the world regarding the pattern of reading behaviour. ▪ The scale intervals should be round and familiar numbers such as 10 and 100.
Kosslyn	1989	▪ Unfamiliar graph types should be avoided
Taylor & Anderson	1986	▪ Rate-of-change graphs should be avoided

Appendix 2: Example of a graph with Measurement Distortion



RGD calculation:

$g1 = 1.6$

$g2 = 4$

$d1 = 164$

$d2 = 192$

$$g3 = 1.6 * \frac{192}{164} = 1.873$$

$$RGD = \frac{4 - 1.873}{1.873} = 113.54\%$$

Picture 2- Measurement Distortion, where the column 2018* was created

Source (1st graph): Mota Engil, Annual report 2018, p:24

Legend: This picture portrays a case of measurement distortion. The increase of the column's height is much higher than the increase of the value, representing a favourable distortion for the company

Appendix 3.1: Previous literature about graph usage and its misleading factors

Country/Continent	Author/Sample and Year analysed	Usage of graphs	KFVs	Selectivity	Orientation Distortion	Measurement Distortion	Presentational Enhancement	Colours
Australia; Oceania	Frownfelter-Lohrke & Fulkerson (2001) ;270; 1984-1994	Mean of 15.69 graphs per company	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Australia; Oceania	Beattie & Jones (1999); 89; 1991	89% of companies use graphs; Mean of 9.4 graphs per company or 10.5 if only the companies using graphs are considered). The most popular graph format is the column one, mainly for KFVs	Sales, Profit, EPS and DPS.	There is evidence of selectivity.	The overall mean positive slope was 31.2º. The is no evidence of orientation distortion.	Material measurement distortions in 34% of the KFV graphs. Most of the cases were favourable to the companies (mainly regarding Profit and DPS).	There is evidence of presentational enhancement. One common example is the lack of proper gridlines.	N.A.
Australia; Oceania	Beattie & Jones (2000a); 50; 1992	N.A.	Earnings, Sales, EPS and DPS.	High evidence of selectivity.	N.A.	N.A.	N.A.	N.A.
Brazil; America	Nascimento (2013); 203; 1997-2009	50% of companies displayed graphs. Column is the main format of graphs (70.78% in 2005).	N.A.	N.A.	N.A.	N.A.	Some evidence of presentational enhancement (1.62 graphs with distortion per report, mainly due to three dimensional graphs and no zero-base line).	N.A.

Country/Continent	Author/Sample and Year analysed	Usage of graphs	KFVs	Selectivity	Orientation Distortion	Measurement Distortion	Presentational Enhancement	Colours
Brazil; America	Miranda, Vieira, Lagioia & Vasconcelos (2008); 37; 2000-2007	27.03% of companies did no present graphs. The mean of graphs per annual report is 8.23 for profitable companies and 2.93 per non-profitable companies. Bar graphs are highly used.	Profitable company: Revenues, sales in volume, EBITDA, expenses Non-profitable company: revenues, EBITDA and market share in case of a non-profitable company.	Profitable companies display more graphs than non-profitable companies. On the other hand, variables with good financial performance are displayed in greater quantities than the remaining ones.	N.A.	N.A.	N.A.	N.A.
Brazil; America	Núñez (2016); 57; 2014	Average of 18.98 graphs per company (n=62) and 20.65 graphs per company (n=57). Column graphs is the main format (52.8% of total graphs).	Net Income, revenue, EBITDA and value added.	Evidence of Selectivity (EBITDA and net income are more displayed in companies with a favorable performance than unfavorable). Overall, the inclusion of a given graph is not, significantly, correlated to its performance. Strong and positive correlation between the increase in EPS and the inclusion of at least one KFV graph.	N.A.	58.9% and 43.04% of the graphs have evidence of measurement distortion, considering the GDI measure and RGD, respectively.	Average of 1.7 unconformities per graph and 16.9 per company. The most frequent violated rules were the lack of scale of the financial variable axis (33.5%) and lack of the zero-base line (28.2% of the cases).	23%, 28% and 25% of graphs use two, three and four colours, respectively. 89.5% of companies use at least one graph related to the company's logo.

Country/Continent	Author/Sample and Year analysed	Usage of graphs	KFVs	Selectivity	Orientation Distortion	Measurement Distortion	Presentational Enhancement	Colours
Canada; America	CICA (1993); 200; 1991	83% of companies depicted graphs; the mean of graphs was 10.1 per company.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Denmark; Europe	Frownfelter-Lohrke & Fulkerson (2001); 270; 1984-1994	Mean of 26 graphs per annual report	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
France; Europe	Beattie & Jones (2000a); 50; 1992	N.A.	Earnings, sales, EPS, DPS and cash flow	N.A.	N.A.	N.A.	N.A.	N.A.
France; Europe	Chekkar & Martinez (2011); 38; 2009	90% of companies display graphs on annual reports	Sales, earnings, profitability and stock performance	N.A.	N.A.	N.A.	N.A.	N.A.
Germany; Europe	Beattie & Jones (2000a); 50; 1992	N.A.	EPS	N.A.	N.A.	N.A.	N.A.	N.A.
Hong Kong; Asia	Frownfelter-Lohrke & Fulkerson (2001); 270; 1984-1994	Mean of 10 graphs per annual report.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Hong-Kong; Asia	Courtis (1997); 691; 1992-1993 and 1994-1995	1992-1993: 38.46% of companies displayed graphs; mean of 5.3 graphs per annual report. 1994-1995: 35.47% of companies displayed graphs; mean of 4.8 graphs per company. Column graphs are the main format.	N.A.	N.A.	N.A.	52% of graph graphics were misleading in 1994-1995.	Evidence of presentational enhancement. The most common violation was the lack of balance scales (38% of the cases); creative visual effects (25% of the cases).	97% of graphs were presented in colour by the companies in 1992-1993. Similar conclusions are taken to the 1994-1995 period.

Country/Continent	Author/Sample and Year analysed	Usage of graphs	KFVs	Selectivity	Orientation Distortion	Measurement Distortion	Presentational Enhancement	Colours
Ireland; Europe	Green, Kirk & Rankin (1993); 117; 1990	83% of the companies studied reported graphs. The mean of graphs was 10.1 per company.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Israel; Asia	Frownfelter-Lohrke & Fulkerson (2001); 270; 1984-1994	The mean of graphs per annual report was 4.67	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Italy; Europe	Frownfelter-Lohrke & Fulkerson (2001); 270; 1984-1994	The mean of graphs per annual report was 12.11	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Italy; Europe	Ianniello (2009); 52; 2005	The mean number of graphs is nine per company, increasing to 10.6 considering only the companies who contains graphs. Column is the main format.	EBITDA; EBIT; net profit	Evidence of selectivity, although it is not significant.	The mean slope is 15%	46% of graphs contain material distortions (>10%). Considering the KFVs, 17.3% of companies have at least one graph with a KFV material distorted graph and the mean score is 90%.	N.A.	N.A.

Country/Continent	Author/Sample and Year analysed	Usage of graphs	KFVs	Selectivity	Orientation Distortion	Measurement Distortion	Presentational Enhancement	Colours
Malaysia; Asia	Rahman, Hamdan & Ibrahim (2014); 54; 1974; 1984, 1994, 2004	1974- 15% of companies display graphs and the mean is point five graphs per annual report; 1984- 41% of companies display graphs and the mean is one point five graphs per annual report; 1994- 59% of companies display graphs and the mean is three point seven graphs per annual report; 2004- 65% of companies display graphs and the mean is three point nine graphs per annual report. Bar graph is the type of graph most used.	Profit and Turnover	N.A.	N.A.	N.A.	N.A.	N.A.
Mexico; America	Frownfelter-Lohrke & Fulkerson (2001); 270; 1984-1994	The mean number of graphs per company is six.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Netherlands; Europe	Frownfelter-Lohrke & Fulkerson (2001); 270; 1984-1994	The mean number of graphs per company is 16.67.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Netherlands; Europe	Beattie & Jones (2000a); 50; 1992	88% of the companies include graphs in their annual reports. The mean of graphs is 7.88 per company,	Earnings, sales, EPS and cash flow.	N.A.	N.A.	There is great evidence of measurement distortion (regarding GDI).	N.A.	N.A.

Country/Continent	Author/Sample and Year analysed	Usage of graphs	KFVs	Selectivity	Orientation Distortion	Measurement Distortion	Presentational Enhancement	Colours
New Zealand; Oceania	Frownfelter-Lohrke & Fulkerson (2001); 270; 1984-1994	The mean of graphs per company is 15.69.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Norway; Europe	Guddal (2016); 52; 2014	82.7% of the companies contain graphs in their annual reports. Average of 12.6 graphs per annual report (15.3, considering only the companies that provide graphs. Column graph is the main format (52.7% of all graphs and 95.3% of all companies):	Revenue, EBITDA, net income and EBIT.	There is no evidence of selectivity.	N.A.	There is evidence of measurement distortions. 19.4% and 16.5% of the graphs contain material distortions (based on GDI and RGDI, respectively).	There is evidence of presentational enhancement with a mean of 1.4 violations per graph. 50.9% of the graphs do not use gridlines and 56% use color to highlight the most recent financial year.	49.7%, 14% and one-point four percent of the graphs include two, three and four colours, respectively. 67.4% of companies contain a relationship between the colour theme and the company's logo colour (s).
Philippines; Asia	Frownfelter-Lohrke & Fulkerson (2001); 270; 1984-1994	The mean of graphs per annual report is three point thirty-six.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Portugal; Europe	Wozniak (2011); 48; 2009	91% of companies display graphs in their annual reports. The mean number of graphs per annual report is 26. Colum graphs is the main format.	Turnover, capital market, EBITDA, EBIT and net income.	There is evidence of selectivity (59% display EBITDA graphically in a favorable financial year).	N.A.	There is evidence of measurement distortion. 73% of graphs display material distortions. 56% of the cases are favourable to the company.	There is evidence of presentational enhancement. 52.5% of the graphs do not display labelled axes.	98% of the companies display at least one colour. 83% of the companies display at least three colours.

Country/Continent	Author/Sample and Year analysed	Usage of graphs	KFVs	Selectivity	Orientation Distortion	Measurement Distortion	Presentational Enhancement	Colours
Portugal; Europe	Bastardo (2015); 48; 2013	94% of the companies display graphs. The mean number of graphs per company is 23. Column graphs is the main type (52% of graphs and used by 85% of companies).	EBITDA, EBIT and net income.	No evidence of selectivity.	Evidence of orientation distortion. The average slope was 26 degrees.	Evidence of measurement distortion. 56% of graphs display material distortions. 73% of the cases are favorable to the company.	Evidence of presentation enhancement. There is an average of 1.9 unconformities per graph.	79% if companies used colours accordingly to their logo's colours.
Spain; Europe	Frownfelter-Lohrke & Fulkerson (2001); 270; 1984-1994	The mean number of graphs per company is 6.75.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Spain; Europe	Benau, Miralles & Martínez (2009); 79; 2003	The mean number of graphs per company is 4. Column graph is the main format (99.04% of all the graphs).	Sales, EPS and DPS.	Evidence of selectivity for net income; sales and EPS. No association between the display of EPS and the performance of the earnings before taxes. Association between the display of Net Income and the performance of EPS.	N.A.	Evidence of measurement distortion. GDI: 50% of the sample has material measurement distortion; RGD: 48.92% of graphs have measurement distortion. Most of the cases are favourable to the company.	N.A.	N.A.
South Africa; Africa	Frownfelter-Lohrke & Fulkerson (2001); 270; 1984-1994	The mean number of graphs per company is 0.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Turkey; Asia	Uyar (2011); 96; 2009	75% of companies used graphs. The mean number of graphs per company is 8.6.	Sales, earnings.	N.A.	N.A.	Evidence of measurement distortion.	N.A.	N.A.

Country/Continent	Author/Sample and Year analysed	Usage of graphs	KFVs	Selectivity	Orientation Distortion	Measurement Distortion	Presentational Enhancement	Colours
U.K.; Europe	Beattie; Dhanani & Jones (2008); 100; 1965-2004	N.A.	N.A.	Evidence of selectivity.	N.A.	Material distortions in 30% and 60% of graphs in 1980 and 2004, respectively.	N.A.	N.A.
U.K.; Europe	Beattie & Jones (2000b); 137; 1988-1992	N.A.	Sales, income, EPS and DPS.	Evidence of selectivity (i.e. display of the KFV graphs was highly correlated to the performance of sales performance). Evidence of selectivity regarding the display of EPS depending on the performance of that variable.	N.A.	N.A.	N.A.	N.A.
U.K.; Europe	Beattie & Jones (1992); 240; 1989	The average number of graphs per annual report is 5.9. Column graphs is the main format.	N.A.	Evidence of selectivity.	N.A.	Evidence of measurement distortion in 30% of the graphs, with a mean exaggeration of 10.7%.	N.A.	N.A.
U.K.; Europe	Beattie & Jones (1997); 91; 1990-1991	80% of the companies use graphs. The mean of graphs per company is 7.7. Bar/column graphs are the main format.	Sales, earnings, EPS and DPS.	Evidence of selectivity (i.e. companies are, significantly, more likely to include an EPS graph when EPS has increased rather than decreased).	The mean deviation from the optimum (45º) is 16.4%. No evidence of significant orientation distortion.	Evidence of measurement distortion: 24% of graphs are materially distorted. The mean level of measurement distortion is six-point nine percent.	Evidence of presentational enhancement. 79.3% and 62.1% of companies (N=58) do not provide gridlines and scaled financial variables axis, respectively.	N.A.
U.K.; Europe	Beattie & Jones (2000a); 50; 1992	N.A.	Earnings, sales, EPS and DPS.	Evidence of selectivity.	N.A.	N.A.	N.A.	N.A.

Country/Continent	Author/Sample and Year analysed	Usage of graphs	KFVs	Selectivity	Orientation Distortion	Measurement Distortion	Presentational Enhancement	Colours
U.S.; America	Frownfelter-Lohrke & Fulkerson (2001); 270; 1984-1994	The mean number of graphs per report is 7.46.	N.A.	N.A.	N.A.	Evidence of measurement distortion. The average distortion level for financial graphs is 81%.	25% of the graphs were three-dimensional; no numerical labels in 35% of the graphs; multiple scales in 2% of the graphs; no scale in 64% of the graphs; reversed time series in 1% of the graphs.	N.A.
U.S.; America	Steinbart (1989); 319; 1986	Bar graphs is the main format (78% of graphs).	Sales, income and dividends	Evidence of selectivity.	N.A.	Evidence of measurement distortion. On average, regarding the KFVs, the distortion is 11%.	N.A.	N.A.
U.S.; America	Beattie & Jones (1997); 85; 1990-1991	92% of companies use graphs. The mean number of graphs per company is 13. Bar/column graphs are the main format.	Sales, earnings, EPS and DPS.	Evidence of selectivity (i.e. KFV were more likely to be displayed when EPS increased, specially over 5 years).	The mean deviation from the optimum (45º) is 16.4%.	Evidence of measurement distortion. 24% of graphs were materially distorted. The mean level of measurement distortion is 15.6%.	Evidence of presentational enhancement. 64.8% and 49.3% of companies (N=71) do not provide gridlines and scaled financial variables axis, respectively.	N.A.
U.S.; America	Beattie & Jones (2000a); 50; 1992	N.A.	Sales, earnings, EPS, DPS and ROCE.	Evidence of graph selectivity, mainly in a five-year analysis. Earnings and EPS are the main determinants of selectivity.	N.A.	Great evidence of measurement distortion, most of the cases, favourable to companies.	N.A.	N.A.

Country/Continent	Author/Sample and Year analysed	Usage of graphs	KFVs	Selectivity	Orientation Distortion	Measurement Distortion	Presentational Enhancement	Colours
U.S.; America	Dilla & Janvrin (2010); 184; 1999-2005	70.7% and 69.6% of companies display at least one KFV in 1999 and 2000, respectively. The average of KFV graphs displayed per company decreases from 1.86 in 1999 to 1.43 in 2005.	Net income, EPS, DPS and operating income.	Evidence of selectivity.	N.A.	N.A.	N.A.	N.A.

Appendix 3.2: Methods used by the Authors – Selectivity and Measurement Distortions

	Methodology		
Author and year	**Sample**	**Selectivity**	**Measurement Distortion**
Beattie & Jones (1992)	Annual reports of 240 large UK companies for 1989.	Chi-square test to determine the association between the use of graphs and the performance of EPS and the performance of that variable displayed.	GDI for turnover; PBT (profit before tax); EPS and DPS. **Sample:** 465 graphs.
Beattie & Jones (1997)	The largest (based on sales) 100 U.S. and 100 U.K. industrial companies from the Times 1000 directory for 1990-1991. **Note:** Financial companies were excluded.	Chi-square for independence between the inclusion of the four KFV (Sales, Earnings, EPS and DPS) and the favourable performance (i.e. increases) of EPS. **Note:** the performance was measured based on a time length of one and five-years.	GDI. **Sample:** 348 graphs.
Beattie & Jones (1999)	Top 100 companies listed on the Australian Stock Exchange.	Chi-square tests for the association between the presence of at least one of the 4 KFV graphs is related to the favourable vs unfavourable financial performance (classified as good or bad on the basis of the directional change in both EPS and the financial variable being displayed.	5% threshold to distinguish material distortions from non-material ones. GDI and Adjusted GDI were distinguished. **Sample:** 146 graphs.
Beattie & Jones (2000)	300 companies in Australia, France, Germany, the Netherlands, the U.K. and the U.S. (50 companies from each country).	Chi-square to the independence between the inclusion of graphs with the performance indicators (i.e. variables displayed, Sales, Earnings, EPS and DPS, based on a 5-year analysis and one-year analysis.	GDI formula Chi-square test to test whether the percentage of companies with favourable GDI scores was significant.
Beattie, Dhanani & Jones (2008)	94 companies from FTSE 500 (2004); 240 companies from FTSE 500 (1989).	Chi-square for the association between the performance of the variables displayed and their display. **Sample:** 156 graphs.	GDI for Sales, Income, EPS and DPS. **Sample:** 156 graphs.
Benau, Miralles &Martínez (2009)	79 Spanish quoted companies in 2003.	Chi-square for the association between the display of a given financial variable and the performance of earnings before taxes and EPS and DPS (dividends per share); and the variable being displayed. **Sample:** 139 graphs.	GDI and RGD **Sample: 139 graphs**

	Methodology		
Author and year	**Sample**	**Selectivity**	**Measurement Distortion**
Bastardo (2015) Supervisor: Professor Leonor Ferreira	Companies listed in the Euronext Lisbon in 2013	Chi-square to test the independence between the display of information is independent form company performance. **Sample:** 144 graphs.	GDI for Net Income **Sample:** 38 graphs.
Dilla & Janvrin (2010)	184 top U.S. companies (from Fortune 500 listing) that were in continual existence from 1999 to 2005.	Chi-square test for the association between Key Financial Variable (KFV) and changes in financial performance (measured by the performance of the variables graphed and others, namely Sales, Net Income, EPS, DPS and Operating Income.	
Núñez (2016) Supervisor: Professor Leonor Ferreira and Rafael Schiozer	57 Brazilian companies that belong to the Bovespa Index in 2014	Chi-Square tests of independence between the use of graphs and the classification of performance ads favourable or unfavourable **Sample:** 111 graphs	GDI and the RGD **Sample:** 158 graphs
Guddal (2016) Supervisor: Professor Leonor Ferreira	52 most traded Norwegian companies, listed on Oslo Stock Exchange Benchmark Index (OSEBX)	Chi-square test for the association between KFV graphs and the company's performance. **Sample:** 204 graphs	GDI and the RGD **Sample:** 83 graphs
Wozniak (2011) Supervisor: Professor Leonor Ferreira	48 companies listed on Euronext Lisbon	Chi-square test for the association between the graphical presentation of particular variable and the effect on year to year change are independent, for EBITDA and Net Income. **Sample:** 48 graphs	**Sample:** 37 graphs
Steinbart (1989)	319 companies included in the Fortune 500 in 1986		GDI; Test to the association between the change in net income and the presence of graphical distortion

Appendix 4: Time-Length

#Years	#Graphs
1	270
2	191
3	153
4	18
5	63
>5	91

$\bar{X} = 2.6$

Appendix 5: Types of Graphs and respective suitability

Type of graph	Suitability
Line Graphs	When one wants to display trends, comparing two or more variables across time.
Bar Graphs	When one wants to compare data between two or more categories. They can also show data over time.
Pie Graphs	When one wants to show proportional data. It shows the composition of a given variable.
Scatter Plot	When one wants to visualize the correlation between two variables across time.
Area Graphs	When one wants to show not only trends, but also the magnitude of such trend.
Dot Plot	When the variable displayed is either quantitative or categorical.
Radar Graphs	When one wants to make multiple comparisons and to see which variables are performing well or weakly within a dataset.
Stacked Graphs	When one wants to show "comparisons between categories of data", breaking down and compare parts of a bar or column.

Appendix 6: Graph Format Overview

Graph Format	Number of graphs	% of Total Graphs	Number of companies with at least one graph	% of companies with at least one graph
Column	276	35.11%	35	87.50%
Doughnut	130	16.54%	21	52.50%
Stacked column	86	10.94%	22	55.00%
Line	81	10.31%	30	75.00%
Mixed column + line	72	9.16%	17	42.50%
Others	40	5.09%	11	27.50%
Bar	29	3.69%	14	35.00%
Pie	25	3.18%	11	27.50%
Mixed stacked column + line	23	2.93%	7	17.50%
Stacked Bar	21	2.67%	8	20.00%
Area	3	0.38%	3	7.50%
Total	786	100%		

Appendix 7.1: Number of colors used per graph

#Colors	#Graphs	% of Graphs
1	358	45.54%
2	309	39.31%
3	78	9.92%
4	26	3.31%
5	14	1.78%
6	1	0.13%
Total	786	100%

$\bar{X} = 1.77$

Appendix 7.2: Association between the graph color and the company's logo

The following formula was applied:

$$ABCGL^{1} = \frac{No.of\ graphs\ with\ the\ colour\ xi}{Number\ of\ graphs} \qquad [1]$$

Where,

ABCGL= *Association between color, graph and logo;*

Xi= *a given color of the logo, excluding white.*

Applying the formula [1], the ABCGL is 58%, rising to 76% the companies whose ABCGL is zero were excluded.

Considering the final sample, all of the companies **display at least one color** (excluding black & white), whose average was 1.77 colors per graph.

[1] Note however, if a given graph has more than one color, the sum for that specific section** is multiplied by (100% minus the share of the logo's colors that could be used in that graph) * for that section. Exemplifying, if the company's logo is red and green and there is one red graph and a red/blue graph, ABCGL is given by: (1/2) +(1/2) *0.5=75%. Another case is when there are two red/green graphs and a red/yellow graph. Here, the adapted formula and respective result becomes 2/3*100%+ 1/3*50%=83.33%. Considering a red/pink/purple logo, if there are two red/green graphs and a red/purple/brown graph (three colors). Here the formula and respective result becomes 2/3*50% + 1/3*2/3=55.56%. This formula takes into account the weight of each "section" in the total number of graphs and the fact that some graphs that only used some logo's colors.
*if a graph has two colors and it only uses one of the two company logo's color, it means that 50 percent of the company logo's color could have been added.
**Here, "section" corresponds to the number of colors that a group of graphs may have (E.g.: in company x, there are 30 graphs with two colors.

Appendix 8: Graph content

Content	*No. of Graphs*	*Percentage of graphs*	*No. of Companies*	*Percentage of Companies*
Residual Financial Information	143	18.19%	31	77.50%
HR & Safety	111	14.12%	24	60.00%
Revenues	87	11.07%	18	47.50%
Operations/Strategy	80	10.18%	15	37.50%
EBITDA	75	9.54%	19	47.50%
Capital Market Data	71	9.03%	29	72.50%
Sustainability & CSR	68	8.65%	11	27.50%
Industry/Macroenvironment	62	7.89%	16	40.00%
Debt	41	5.22%	17	41.50%
Net Income	26	3.31%	17	41.50%
Corporative	12	1.53%	8	20.00%
Others	10	1.27%	6	15.00%
Total	786	100%		

Content	*No. of Graphs*	*Percentage of*	*No. of Companies*	*Percentage of*
Financial	443	56.36%	36	90.00%
Non-financial	343	43.64%	30	75.00%
Total	786	100.00%		

Appendix 9: Key financial variables (KFVs)

Content	Number of companies displaying KFVs	% of companies	Number of graphs displaying each variable	% of KFV's graphs
Capital Market Data	29	72.50%	71	23.67%
EBITDA	19	47.50%	75	25.00%
Revenues	18	45.00%	87	29.00%
Debt	17	42.50%	41	13.67%
Net Income	17	42.50%	26	8.67%
Total			300	100%

Appendix 10: Favorable versus Unfavorable Measurement Distortions (in percentage)

Variables/ Significant Distortions	Total Significant Measurement Distortions	% Overstating favourable trend	% Understating negative trend	% Favourable Distortion	% Understating Favourable Distortion	% Overstating Unfavorable Trend	% Unfavorable Distortion
Debt	22	59.09%	9.09%	68.18%	27.27%	4.55%	28.21%
EBITDA	39	30.77%	41.03%	71.79%	12.82%	15.38%	28.21%
Net Income	12	25.00%	16.67%	41.67%	41.67%	16.67%	58.33%
Revenues	38	33.33%	22.22%	55.26%	25.00%	19.44%	44.74%
Market Capital	4	50.00%	25.00%	75.00%	0.00%	25.00%	25.00%
Total	115	37.17%	25.66%	62.61%	22.12%	15.04%	37.39%

Appendix 11.1: Presentational Enhancement (violations per type)

Violated Rule	No. of violations per rule	No. of violations per graph	Percentage of violations	Percentage of graphs with this type of distortion	No. of companies	Percentage of Companies
Zero base line	172	0.621	48.59%	59.25%	18	66.67%
Different color/hue in the last	61	0.220	17.23%	19.86%	12	44.44%
Three-dimensional effect	30	0.108	8.47%	10.27%	3	11.11%
Clockwise direction of slices	27	0.097	7.63%	9.25%	10	37.04%
Five slices per pie/doughnut	19	0.069	5.37%	6.51%	6	22.22%
Absence of title	16	0.058	4.52%	5.82%	9	33.33%
Multiple Scale	13	0.047	3.67%	4.79%	6	22.22%
Absence of labelling	8	0.029	2.26%	2.74%	1	3.70%
Time orientation	6	0.027	1.69%	2.05%	2	7.41%
Obtrusive	2	0.007	0.56%	0.68%	2	7.41%
Total	354	1.19	100%	81.16%		

Appendix 11.2: Summary of the Results for Presentational Enhancement

Fact	Statistical Test: P-value	Conclusion
Only 11.19% of the graphs analysed do not have any violations to distract users.	$H_0: U = 0$ $H_1: U \neq 0$	With an average of 1.19 distortions per graph and a standard error of 0.05, a Z-Score of 24.97 was obtained. The null hypothesis is therefore rejected meaning that there is evidence of presentational enhancement.

Appendix 12.1: Orientation Distortion

Difference between the optimal angle and the one computed	No. of Variables	Percentage
[0; 5[	20	9.52%
[5; 10[	7	3.33%
[10; 20[	32	15.24%
[20; 40[	88	41.90%
[40; ∞ [	63	30.00%
Total	210	100.00%

Appendix 12.2: Summary of the results of Orientation Distortion

Fact	Statistical Test: P-value	Conclusion
Only 3 graphs provided a 45 degrees' angle, corresponding to a 1.43% of the N analysed for this distortion.	$H_0: U = 45^0$ $H_1: U \neq 45^0$	With an average of 22.22 degrees and a standard deviation of 21.97, the Z-Score[2] computed was 15.02. The null hypothesis is therefore rejected, meaning that there is statistical evidence of Orientation Distortion.

Appendix 13.1: Matrix of correlation between variables

Variables	No of significant Measurement distortions	Assets	Time length	BoD change	PSI-20
No of significant Measurement Distortions	1	-0.166	0.517	0.409	-0.053
Assets	-0.166	1	-0.156	-0.218	0.414
Time length	0.517	-0.156	1	0.148	-0.315
BoD change	0.409	-0.218	0.148	1	-0.031
PSI-20	-0.053	0.414	-0.315	-0.031	1
Meaning of each variable	Number of significant and favorable distortions for the company	Assets of the company, in million, for a given year.	Number of years displayed (on average) per graph.	Number of years remaining until the change of the current board of directors.	Whether the company is quoted on PSI-20 or not. This is a dummy variable that takes a value of one if quoted on PSI-20 and 0 if not quoted on PSI-20.

[2] $Z_i = \frac{\bar{X} - H_0}{\sqrt{\frac{\sigma_i}{n_i}}}$

Appendix 13.2: Coefficients of correlation

Expected correlation against graph Measurement Distortion versus correlation obtained	Expected correlation	Correlation obtained	Coefficient of correlation	P-value
Assets	(+)	(-)	-0.166	43.82%
Time length	(+)	(+)	0.517	0.97%
BoD Change	(+)	(+)	0.409	16.52%
PSI-20	(+)	(0)	-0.053	80.57%

Appendix 13.3: Test to the Hypotheses[3]

Hypotheses	Applicable/Non-applicable
H1	Non-applicable
H2	Applicable
H3	Non-applicable
H4	Non-applicable
H5	Non-applicable

Appendix 14: Number of Graphs: general

	Initial Sample (56)	Final Sample (40)
Total number of Graphs	916	786
Average Number of graphs	16.4	19.65
Minimum	0	1
Maximum	85	85
Median	9.0	13
Standard deviation	18.6	18.47
Coefficient of variation	1.14	0.94

[3] Based on $\alpha=0.05$.

Appendix 15: List of companies from Euronext Lisbon – final sample[4]

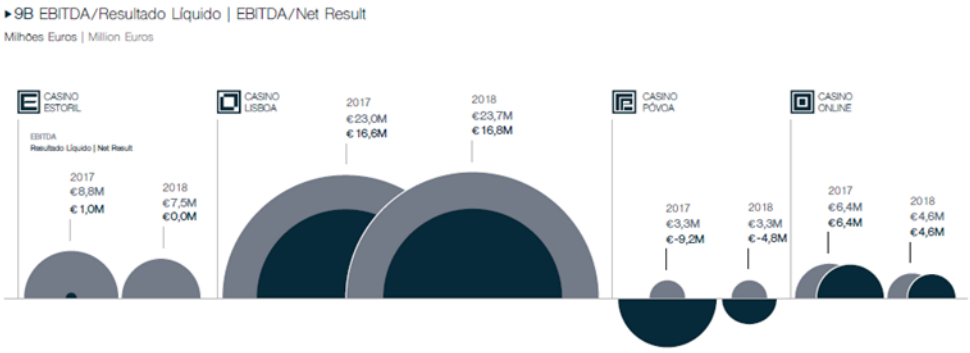
	Company	Industry	Super Sector	# Graphs	PSI-20
1	**Altri, SGPS, S.A.**	Industrials	Industrial Goods & Services	16	Yes
2	**Banco Comercial Português, S.A.**	Financials	Banks	63	Yes
3	**Cofina, SGPS, S.A.**	Consumer Services	Media	2	No
4	**Conduril**	Industrials	Construction & Materials	7	No
5	**Corticeira Amorim, SGPS, S.A.**	Consumer Goods	F&B	22	Yes
6	**CTT-Correios de Portugal, S.A.**	Industrials	Industrial Goods & Services	20	Yes
7	**EDP- Energias de Portugal, S.A.**	Utilities	Utilities	37	Yes
8	**Estoril Sol, SGPS, S.A.**	Consumer Services	Travel & Leisure	18	No
9	**Farminveste, SGPS**	Healthcare	Healthcare	9	No
10	**F. Ramada- Investimentos,**	Industrials	Basic Resources	13	Yes
11	**Futebol Clube do Porto- Futebol, SAD**	Consumer Services	Travel & Leisure	7	No
12	**Galp Energia, SGPS, S.A.**	Oil & Gas	Oil & Gas	28	Yes
13	**Glintt- Global Intelligent**	Technology	Technology	8	No
14	**Grupo Media Capital, SGPS,**	Consumer Services	Media	20	No
15	**Ibersol, SGPS, S.A.**	Consumer Services	Travel & Leisure	13	Yes
16	**Impresa, SGPS, S.A.**	Consumer Services	Media	4	No
17	**Inapa- Investimentos,**	Industrials	Basic Resource	4	No
18	**Jerónimo Martins, SGPS, S.A.**	Consumer Services	Retail	43	Yes
19	**Lisgráfica- Impressão e Artes**	Industrials	Industrial Goods & Services	4	No
20	**Martifer, SGPS, S.A.**	Industrials	Industrial Goods & Services	36	No
21	**Mota Engil, SGPS, S.A.**	Industrials	Construction & Materials	26	Yes
22	**Nexponor- SICAFI, S.A.**	Financials	Real Estate	1	No
23	**NOS, SGPS, S.A.**	Consumer Services	Media	85	Yes
24	**Oli Sistemas, S.A.**	Industrials	Construction & Materials	6	No
25	**Patris Investimentos, SGPS, S.A.**	Financials	Financial Services	4	No
26	**Reditus, SGPS, S.A.**	Technology	Technology	13	No
27	**REN-Redes Energéticas**	Utilities	Utilities	49	Yes
28	**SAG Gest- Soluções Automóvel**	Consumer Services	Retail	19	No
29	**SEMAPA- Sociedade**	Industrials	Construction & Materials	32	Yes
30	**SONAE, SGPS, S.A.**	Telecommunications	Telecommunications	43	Yes
31	**SONAE Capital, SGPS, S.A.**	Financials	Financial Services	27	Yes
32	**SONAE COM, SGPS, S.A.**	Telecommunications	Telecommunications	1	No
33	**SONAE Indústria, SGPS, S.A.**	Industrials	Construction & Materials	25	No
34	**Sport Lisboa e Benfica- Futebol,**	Consumer Services	Travel & Leisure	12	No
35	**Sporting Clube de Portugal-**	Consumer Services	Travel & Leisure	6	No
36	**Sporting Clube de Braga-**	Consumer Services	Travel & Leisure	6	No
37	**Teixeira Duarte, S.A.**	Industrials	Construction & Materials	39	No
38	**The Navigator Company**	Basic Materials	Basic Resources	7	Yes
39	**Toyota Caetano, S.A.**	Industrials	Industrial Goods & Services	9	No
40	**VAA Vista Alegre, SGPS, S.A.**	Consumer Goods	Personal Goods	2	No

[4] The following companies were excluded from the initial sample: ADELPHI GERE; COMPTA; COMPAM; EDP RENOVÁVEIS; EURONEXT; FLEXDEAL; FENALU; GRÃO PARÁ; ISA; LITHO FORMAS; MONUMENTAL RESIDENCE; NOVABASE; OREY; PHAROL; RAIZE and SONAGI.

Appendix 16: Number of graphs: PSI-20 VS Non-PSI 20

	PSI 20	Non-PSI 20
Total number of Graphs	524	262
Average Number of graphs	32.75	10.92
Minimum	7	1
Maximum	85	39
Median	27.5	7
Standard deviation	19.75	10.18
Coefficient of variation	0.60	0.93

Appendix 17.1: Example of classification of Graphs

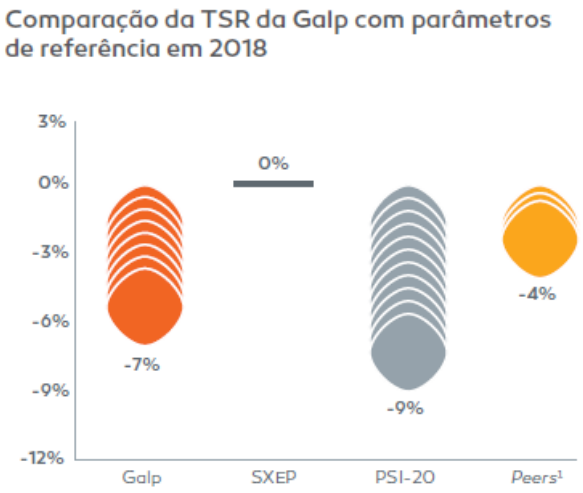


Picture 1 – Graphs classified as "Others"

Source: Estoril-Sol, Annual report 2018 p:78

Legend: This graph, taken from Estoril Sol (2018), is a good example of a graph that was classified as "Others".

Appendix 17.2: Example of a logo's format on Graphs

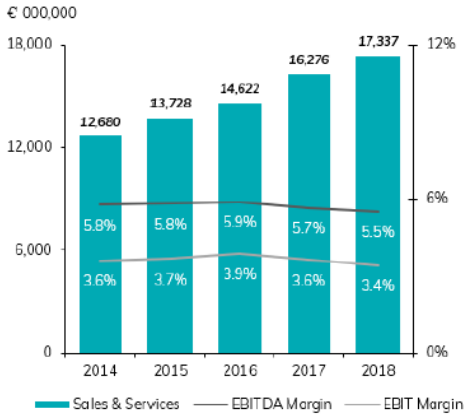


Picture 2 – Graphs with the company's logo format

Source: Galp, Annual report 2018 p:28

Legend: This graph, taken from Galp (2018), is a good example of a graph that uses a custom format (inspired by the logo)

Appendix 17.3: Example of a Graph without Measurement Distortion



RGD calculation:

g1=4.0

g2=4.2

d1=16.276

d2=17.337

$$g3 = 4.0 * \frac{17.337}{16.276} = 4.261$$

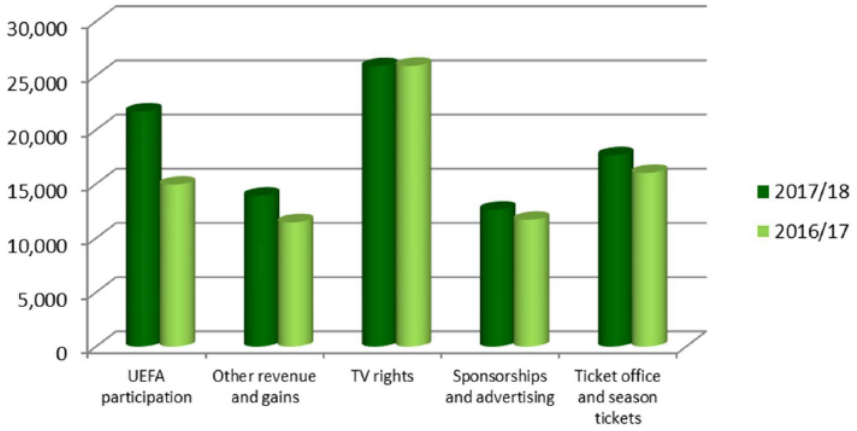
$$RGD = \frac{4.2 - 4.261}{4.261} \simeq 0$$

Picture 3: Measurement distortion

Source: Jerónimo Martins, Annual Report 2018 p:12

Legend: This graph, taken from Jerónimo Martins, provides a correct graph regarding the measurement distortion. The increase of the height of the column regarding *Sales & Services*, is exactly the same as the increase in terms of monetary value.

Appendix 17.4: Example of a Graph with Presentational Enhancement and Orientation Distortion

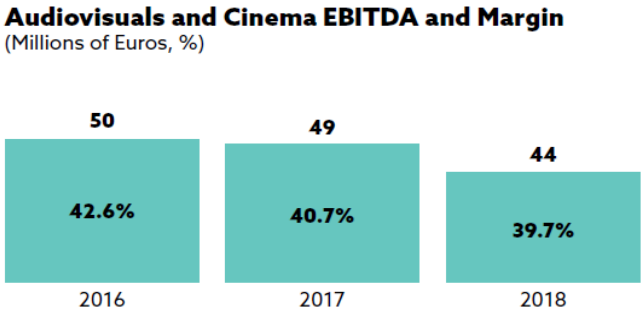


Picture 3: Presentational Enhancement

Source: Sporting Clube de Portugal, Annual Report 2018 p:19

Legend: Taken from Sporting Clube de Portugal, this is an example of a wrong time orientation (not from left to right); orientation distortion (difficult to percept any differences between different years because this graph was based on a very small scale.

Appendix 17.5: Example of a Graph without Orientation Distortion

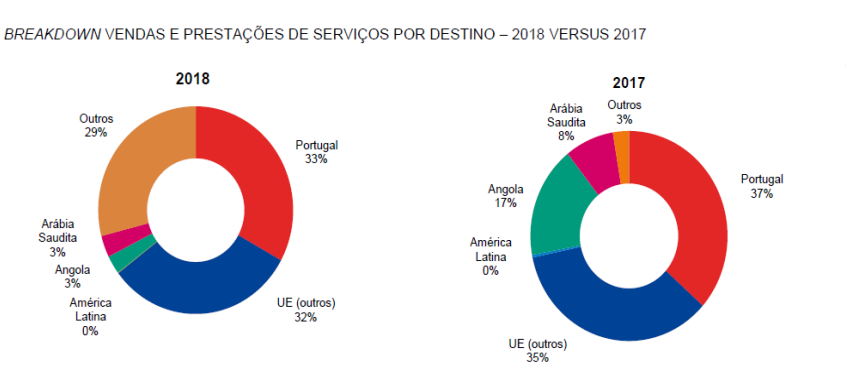


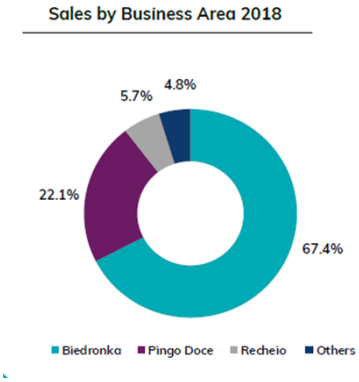
Picture 4: Orientation Distortion

Source: NOS, Annual Report 2018 p:47

Legend: This example, taken from NOS, is an example of an optimum angle between the last two columns (45º). This enables the user to have a perfect perception of the evolution between 2017 and 2018 regarding the financial results.

Appendix 17.6: Example of a Graph with Presentational Enhancement: Doughnut graph



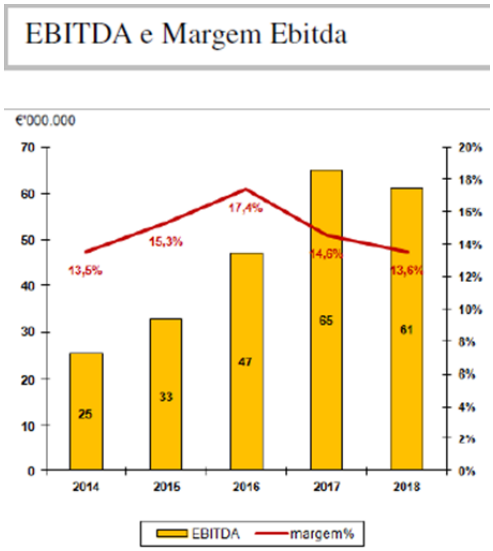


Source: Martifer, Annual Report 2018 p: 44

Jerónimo Martins, Annual Report 2018 p:16

Legend: The first graph, taken from Martifer, provides a wrong doughnut graph, since it does not follow the clockwise. The second one, taken from Jerónimo Martins, provides an example of what a Doughnut graph should be-clockwise direction.

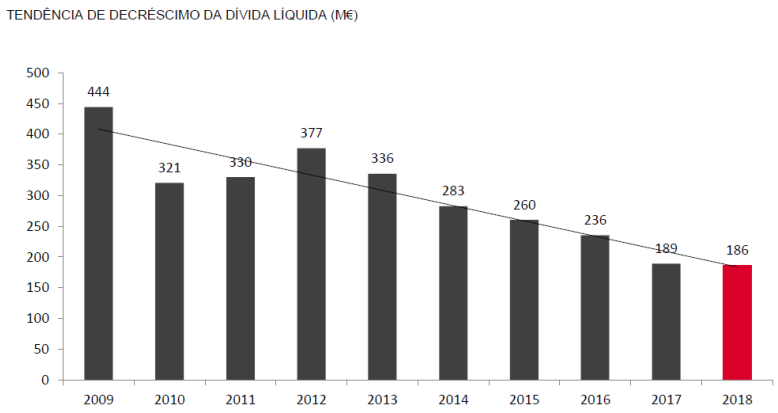
Appendix 17.7: Example of a Presentational enhancement – Graph with Multiple-Scale



Source: Ibersol, Annual Report 2018, p:6

Legend: This graph, taken from Ibersol, provides an example of a double scale usage, which may cause some difficulties when analysing graphs.

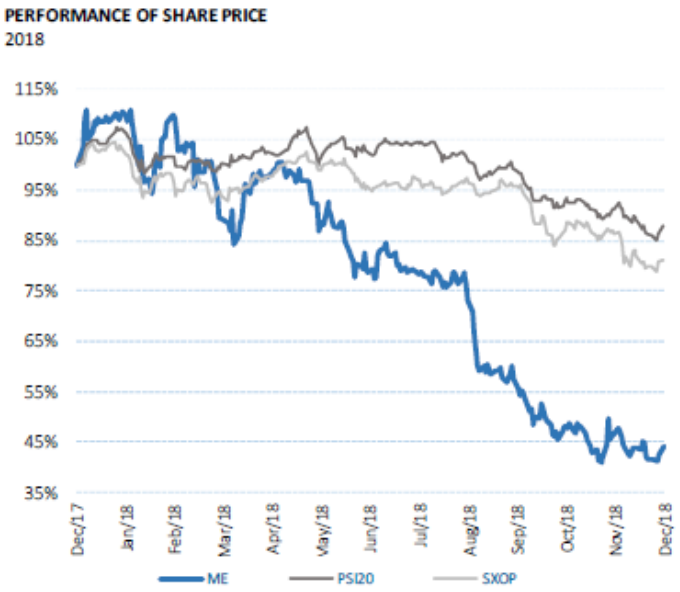
Appendix 17.8: Example of a Graph with Presentational Enhancement – Different Color



Source: Martifer, Annual Report 2018 p:47

Legend: This graph, taken from Martifer, moves the user's attention to the last year, highlighting it with a different colour. This is favourable to the company because in 2018, Net Debt is much lower than 2009.

Appendix 17.9: Example of a Graph with Presentational Enhancement – Lack of a Zero-Base Line



Source: Mota-Engil, Annual Report 2018 p:59

Legend: This graph, taken from Mota-Engil, is an example of a scale that do not start from 0.

Appendix 18: Distortions per type and company

Companies	Selectivity	N	Measurement Distortion	N	Orientation Distortion	N	Presentational Enhancement	N	Total	Distortions/No. of Graphs
Altri	0	0	0	0	0	0	3	4	16	0.19
Corticeira Amorim	7	15	11	15	11	11	7	6	22	1.64
CTT	0	0	0	0	0	0	3	3	20	0.15
EDP	3	7	4	7	5	5	13	7	37	0.68
Estoril Sol	0	8	1	8	0	7	0	11	18	0.06
Farminveste	0	0	0	0	0	0	0	0	9	0.00
FCP	0	1	0	1	1	1	5	3	7	0.86
Galp	1	1	1	1	0	0	1	1	28	0.11
Glintt	6	6	4	6	7	7	4	4	8	2.63
Ibersol	0	2	5	12	4	4	5	7	13	1.08
Impresa	1	4	0	4	2	2	2	2	4	1.25
Jerónimo Martins	12	19	7	19	15	15	18	14	43	1.21
Lisgráfica	5	5	4	5	1	1	1	1	4	2.75
Martifer	1	1	0	1	2	2	6	6	36	0.25
Mota-Engil	22	35	9	35	15	15	34	26	26	3.08
NOS	16	20	12	20	20	21	33	31	85	0.95
Oli Sistemas	4	5	2	5	1	1	0	3	6	1.17
Reditus	0	2	0	2	4	4	8	6	13	0.92
REN	2	6	4	6	5	5	4	5	49	0.31
Semapa	24	38	15	38	38	38	70	38	32	4.59
SLB	3	9	5	9	7	7	7	8	12	1.83
SONAE	13	17	6	17	11	12	35	26	43	1.51
SONAE Capital	7	8	5	8	8	8	29	15	27	1.81
SONAE Industry	1	13	7	13	13	13	18	13	25	1.56
Sporting	4	7	3	7	8	9	19	6	6	5.67
Sporting de Braga	0	5	0	5	5	5	3	3	6	1.33
Teixeira Duarte	6	17	10	17	17	17	33	28	39	1.69
Total	144	25	115	261	207	210	354	277	634	1.24

Appendix 19: Summary of the existence of significant distortions

Type of Distortion	**Existence (Yes or No)**
Selectivity	Yes
Measurement Distortion	No
Orientation Distortion	Yes
Presentational Enhancement	Yes

Appendix 20: Dependent Variable – Significant Measurement Distortions per graph (Total)

Companies	Number of Significant Measurement Distortions	Number of Graphs	Significant Measurement Distortions per graph
Corticeira Amorim	11	22	0.50
EDP	4	37	0.11
Estoril Sol	1	18	0.06
FCP	0	7	0.00
Galp	1	28	0.04
Glintt	4	8	0.50
Ibersol	5	13	0.38
Impresa	0	4	0.00
Jerónimo Martins	7	43	0.16
Lisgráfica	4	4	1.00
Martifer	0	36	0.00
Mota Engil	9	26	0.35
NOS	12	85	0.14
Oli Sistemas	2	6	0.33
Reditus	0	13	0.00
REN	4	49	0.08
Semapa	15	32	0.47
Benfica	5	12	0.42
SONAE	6	43	0.14
SONAE Capital	5	27	0.19
SONAE Indústria	7	25	0.28
Sporting CP	3	6	0.50
Sporting de Braga	0	6	0.00
Teixeira Duarte	10	39	0.26
Total	**115**	**589**	**0.20**

Appendix 21: Descriptive Statistics of significant Measurement distortions on Graphs

Total number of significant measurement distortions	115
Average number of distortions	4.79
Minimum	0
Maximum	15
Median	4
Standard deviations	4.12
Coefficient of variation	1.16

Appendix 22: Location of Graphs

	Director's report and highlights	Management Report	Corporate Governance	Sustainability	Others	Total
Altri	0	5	0	11	0	16
Cofina	2	0	0	0	0	2
Conduril	0	2	0	0	5	7
Corticeira	0	11	0	11	0	22
CTT	0	11	9	0	0	20
EDP	0	33	4	0	0	37
Estoril Sol	0	18	0	0	0	18
Farminveste	0	7	0	0	2	9
FCP	7	0	0	0	0	7
Galp	0	21	0	5	2	28
Glintt	0	8	0	0	0	8
Ibersol	0	11	0	2	0	13
Impresa	4	0	0	0	0	4
Inapa	4	0	0	0	0	4
Jerónimo	0	27	1	15	0	43
Lisgráfica	0	4	0	0	0	4
Martifer	2	23	0	11	0	36
Media Capital	0	0	0	20	0	20
Millenium BCP	0	63	0	0	0	63
Mota Engil	2	24	0	0	0	26
Nexponor	1	0	0	0	0	1
NOS	0	72	1	0	12	85
Oli Sistemas	0	6	0	0	0	6
Patris	0	4	0	0	0	4
Ramada	0	4	0	0	9	13
Reditus	5	5	2	0	0	13
Benfica	0	12	0	0	0	12
REN	1	40	1	7	0	49
SAG	0	19	0	0	0	19
SEMAPA	0	32	0	0	0	32
SONAE	11	15	0	17	0	43
SONAE Capital	12	4	0	11	0	27
SONAE COM	0	1	0	0	0	1
SONAE	5	20	0	0	0	25
Sporting CP	0	6	0	0	0	6
Sporting de	0	6	0	0	0	6
Teixeira Duarte	0	39	0	0	0	39
The Navigator	0	3	3	0	1	7
Toyota Caetano	0	9	0	0	0	9
Vista Alegre	0	2	0	0	0	2
%	7.01%	72.23%	2.55%	14.14%	4.08%	100%

Appendix 23: Descriptive Statistics of Significant Measurement Distortions per graph

Average number of Significant Measurement Distortions per graph	0.20
Minimum	0
Maximum	0.50
Median	0.17
Standard deviations	0.24
Coefficient of variation	0.83